# Space Weather Technical Forecast

Issued on Wednesday, 05 January 2022 at 13:21 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Mainly quiet conditions, chance of minor geomagnetic activity over the weekend.**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity was Very Low over the past 24 hours, with only B-flares observed. There are two sunspot regions on the visible disc, AR2924 Cao/Beta in the far southeast and a new unnumbered Cso/Beta region near the southeast limb, however the analysis with the new region is low confidence due to its near-limb location. No Earth-directed CMEs have been observed in the available imagery.

**Solar Wind / Geomagnetic Activity:** Solar winds as observed at L1 were slightly elevated between 390-440km/s. Density has been averaging around 5ppcc. The interplanetary magnetic field strength (IMF Bt) was weak between 5 and 7nT, with a mostly positive Bz value. The Phi angle has also been mainly positive (magnetic field directed away from the Sun). Geomagnetic activity has been mostly Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2MeV) has been background or moderate levels. Electron fluence was below the Active threshold (1e8), and has now levelled off after at around 3e7 integrated pfu after a brief rising trend. 3.5e7 integrated pfu was recorded at 05/0000 UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Mostly Very Low solar activity is expected, with a chance of increasing to Low at times (C-class flaring) from either of the sunspots on the disc. Through day 3 and into day 4 (7th and 8th), a return of two old active regions (ex2907, ex2908) from the previous rotation will potentially increase activity bringing a slightly increasing chance of isolated M-flares.

**Solar Wind / Geomagnetic Activity:** There are currently no Earth-directed CMEs. Solar winds are expected to remain mainly slow and ambient until later on day 4, when a CIR and the arrival of a coronal hole fast wind is anticipated. Mainly Quiet geomagnetic conditions are expected until then, then increasing to Unsettled to Active (Kp3-4) with a slight chance of G1/Minor storm intervals (Kp5) on day 4 (8th).

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux is expected to remain at background levels in the absence of solar activity. The High energy electron flux (greater than 2MeV) may exceed the High (1e3pfu) level occasionally at diurnal peak during days 1 and 2 (5th and 6th), but otherwise staying at mainly moderate levels. The electron fluence is likely to stay mainly settled at 3 to 7e7 integrated pfu (perhaps peaking on day 3, 7th Jan), whilst likely remaining below the Active level (1e8).

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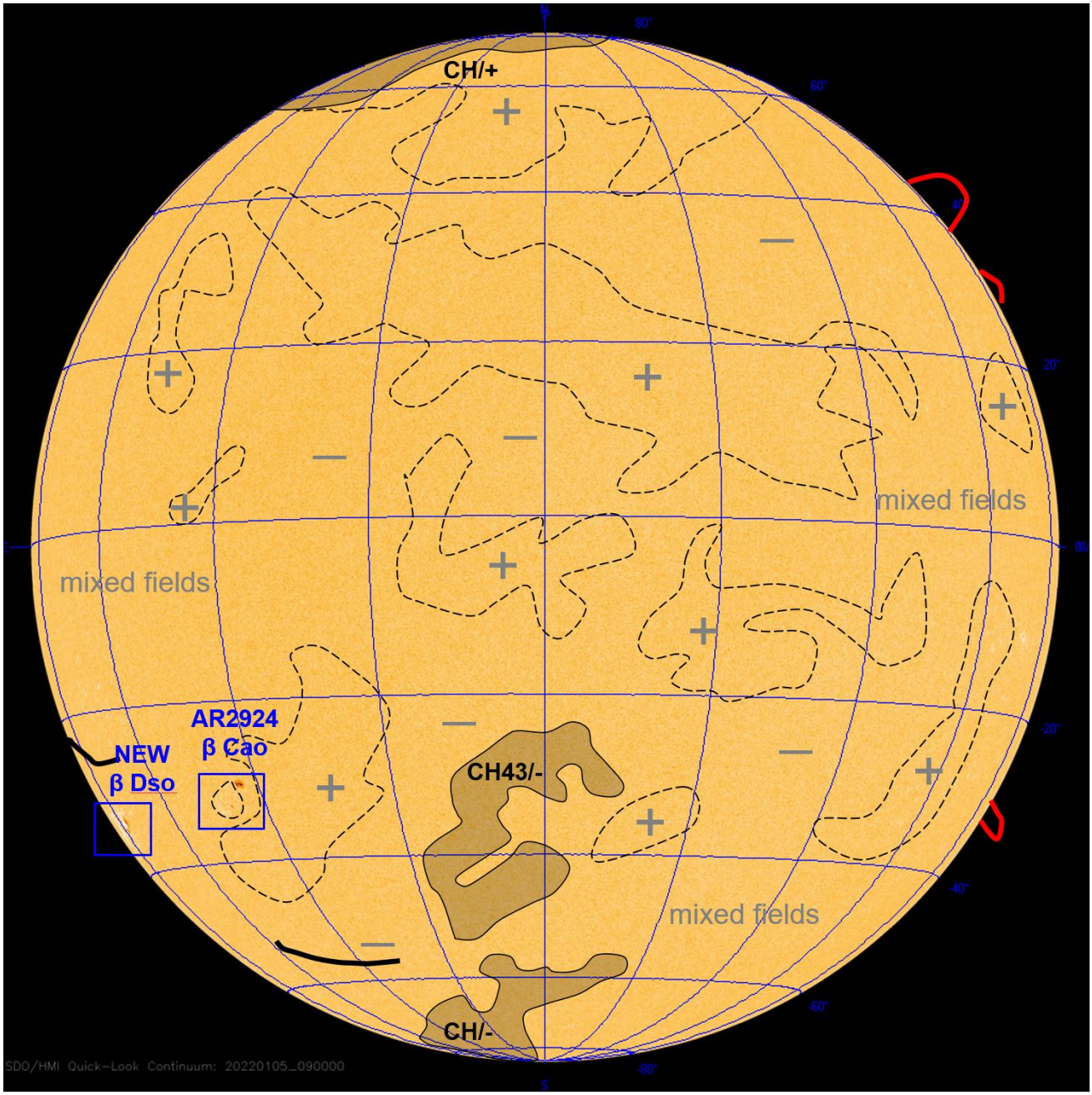
**Figure 1. Solar Analysis Valid 05/0900UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

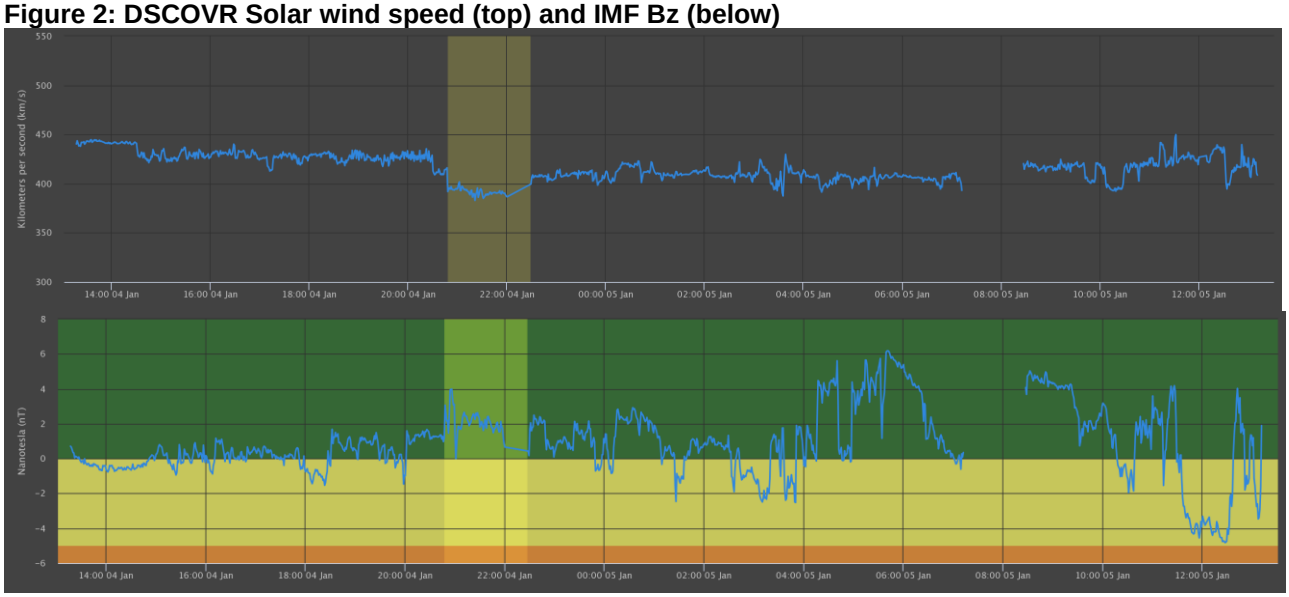
There no Earth-directed CMEs. Mainly ambient (slightly elevated) solar winds are expected to continue with no features expected until the CIR and fast wind of CH43 (-ve) arrive on day 4. This is a new feature on this rotation, based on comparing SDO AIA imagery from last rotation with current the coronal hole has become more prominent and Earth-facing. So confidence is moderate on timing and strength, with best estimate of elevated solar between 500-600km/s. This feature has yet to be observed at STEREO A, however this spacecraft is now only observing conditions around 2.7 days ahead of Earth. A Solar Sector Boundary Crossing (SSBC) may also preceed the coronal hole as we are currently connected to a positive region of the current sheet (Phi Angle is currently positive) and the coronal hole is negative. This may allow for a temporary unsettled period in geomagnetic activity.

On the whole, mainly Quiet geomagnetic activity is forecast until day 4 (8th Jan), with Unsettled to Active and a slight chance of G1/Minor Storms thereafter.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 1 | 5 | 25 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections – None Expected

**Figure 2: DSCOVR Solar wind speed (top) and IMF Bz (below)**

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# Met Office Space Weather Technical Forecast

## Radio Blackouts - X-Ray Flares:

Solar Activity is currently Very Low. There are two active regions containing sunspots on the visible disc, however these spots are currently both small and simple. AR2924 Cao/Beta is the only numbered sunspot, and has been slowly developing in the southeast quadrant through the last 24-36 hours. This is followed by a currently unnumbered region, which has only recently rotated onto the visible disc. Despite some notable looping visible on SDO aia-171 imagery and a strong signal on far-side products, this currently appears to be a small Dso/Beta region, situated within a region of strong plage. This was potentially ex-2906 on the previous rotation. A further strong region is also possible around the limb on day 4 (8th), as evident by its helioseismic signature. This corresponds to the region of ex2907 and ex2908 on the previous rotation, both of which produced M-flares on their previous transit across the Sun.

Very Low activity is expected to persist, with a chance of rising to Low from any C-flares from either of the two sunspots. This risk will increase day 3 (7th) onward as further regions rotate into view, with a slightly increased chance of M-flares.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 1 | 2 | 5 | 10 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist at this level in the absence of solar activity.

| Radiation Storms | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ S1 | No | 1 | 1 | 1 | 1 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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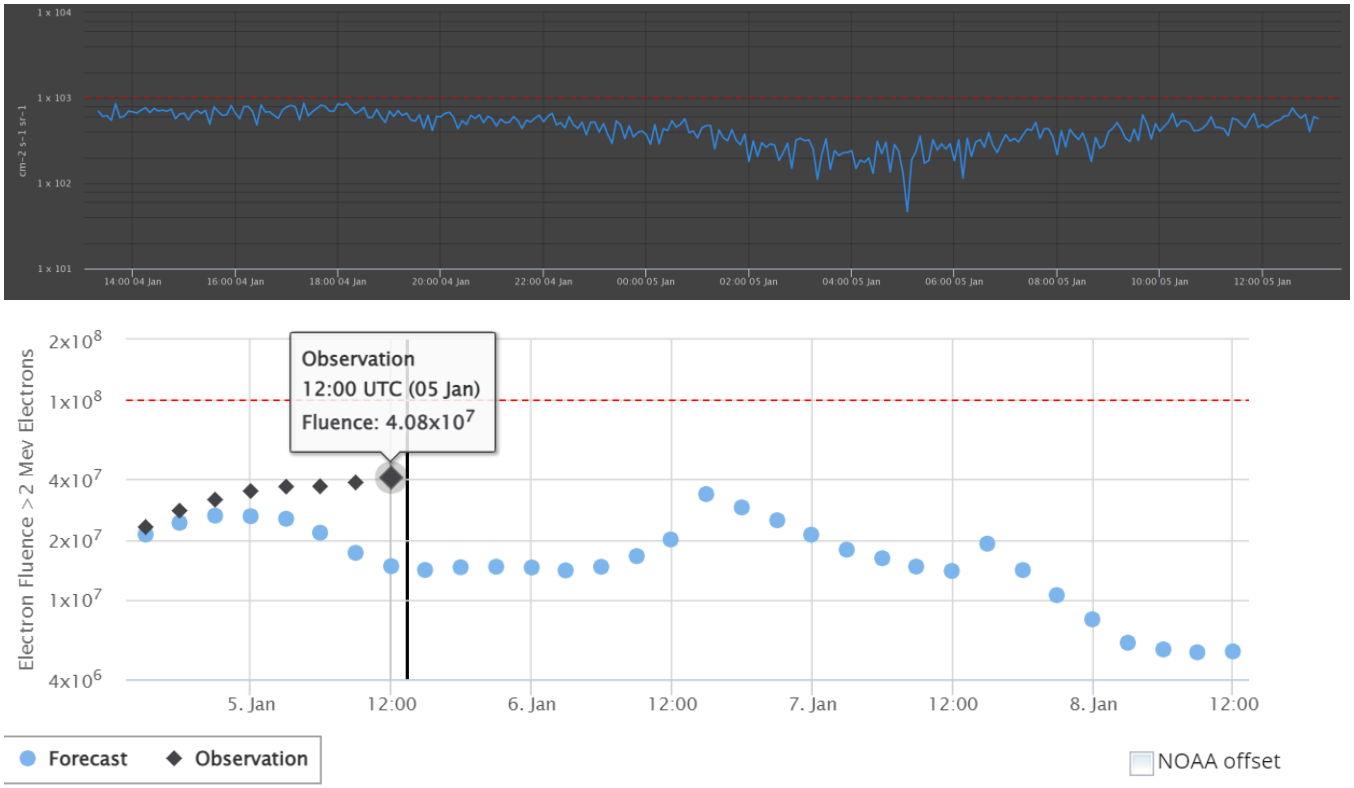
## High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at predominately moderate levels, but expected to see peak values getting close to 1e3pfu on diurnal maximums since the solar wind has now relaxed which may allow the peak radiation belt flux to expand outward to GEO (where GOES is measuring it). The associated 24 hour fluence is currently below the Active (1e8 integrated pfu) threshold and will likely remain below through the period, albeit rising slightly day on day.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 10 | 20 | 20 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 3: GOES16 Electron Flux (top) and current Met Office REFM model showing a very slight rising trend whilst likely to remain well below threshold (below)**

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